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(71) Applicant *(for all designated States except US):* TULIP INTERNATIONAL A/S [DK/DK]; Havnegade 24, DK-7100 Vejle (DK).

(72) Inventor; and
(75) Inventor/Applicant *(for US only) :* MAGÅRD, Tom [DK/DK]; Havnegade 24, DK-7100 Vejle (DK).

(74) Agent: SKØTT-JENSEN, K.; Patentingeniører A/S, Lemmingvej 225, DK-8361 Hasselager (DK).

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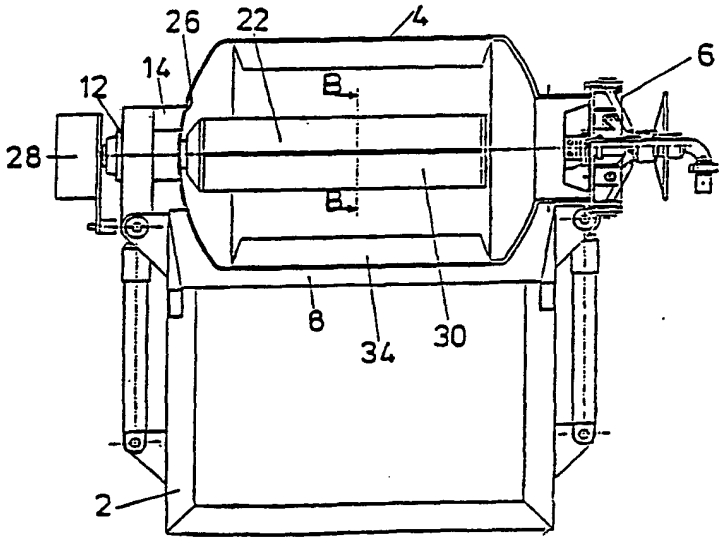

(57) Abstract

At curing meat such as pork, beef or veal by adding brine to the meat preferably by injection, and massaging the meat in a closed container (4), it appears that the process time can be reduced significantly thereby, that the meat at the massaging is exposed to ultrasound as well as alternate pressure, changing between vacuum and overpressure. During the overpressure phases carbon dioxide respectively nitrogen is added. The method can be carried out in an equipment comprising a rotatable container (4) connected to a pressure and vacuum source. For effective transfer of the ultrasound to the meat in the container, ultrasound transducers are placed in a closed tube arranged coaxially in the container.

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A method and equipment for curing meat.

The present invention relates to a method as well as an equipment for curing meat.

When curing meat such as pork an injector is used for injecting brine into the meat. In a Danish patent application No. 627/91 filed at the same time as the present invention it is proposed to inject dispersed brine into the meat, previously it was necessary to add the insoluble quantity of brine ingredients as a dry substance and massage these into the meat. The process time of the hitherto known method is of the time consumption 32-36 hours of which approximately 10 hours elapse as a rest period in order to allow time for the brine to disperse in the meat. The brine disperses at a speed of approximately 1 cm during 10 hours, and as the needles of an injector typically are spaced at 2-2 1/2 cm the brine is dispersed in the meat in the course of approximately 10 hours. Thus it seems difficult to reduce the process time as there is a limit to the density of the needles in an injector. However, the brine being evenly dispersed in the meat does not alone assure a high quality. Other and just as important factors must be considered, too, factors of a more chemical/biological nature. By way of example it is important that the brine obtains a good contact with the myofibrillar proteins of the meat fibres, as these proteins constituting approx. 50% of the protein content of the meat are soluble in the brine and present a good water-binding capacity. Consequently it is important to release the myofibrillar proteins or make them attainable. It is another chemical fact that the myoglobin being the red pigment in meat is inherent in the sarcoplasma proteins that are water-soluble. During curing the myoglobin must react on the nitrite of the brine during formation of the red nitromyoglobin that results in a thermally

stable red colour which is essential for the meat to retain its colour after the subsequent heat treatment. It is important, too, that proteins be released which seep to the surface of the meat such that several lumps of meat can be formpressed into one piece of meat possessing a good sliceability of the final product. Furthermore the meat must be tenderized for the end product to achieve a good mastication texture. These are only some of the complexities to be considered when curing meat.

The sole object of the invention was to reduce the lengthy process time of curing meat and preferably such that the quality of the final product be improved, but under no circumstances be lowered. According to the invention this is achieved by subjecting the meat upon injection of brine at a subesequent tumbling to ultrasound as well as an alternating pressure between vacuum and overpressure, as during the pressure phases inactive gases such as carbon dioxide and nitrogen are added. The combined effect of the ultrasound and the alternating pressure turns out to affect the meat very dramatically. It appears that by a short process time also an even dispersion of the brine in the meat, release of the proteins as well as a tenderizing are achieved. It turns out that it is possible to reduce the process time such that the meat can be processed and packed for delivery within a normal working day of 7 or 8 hours and that without lowering the quality of the finished product, in fact an improved quality is noticed. The physical/-chemical conditions present during the process are not fully realized, but it is believed that the alternating pressure and the ultrasound cause a mechanical processing of the meat that partly disperses the membranes of the muscle structure and releases protein as well as causing a capillary effect/pulsation in the muscle tissue that facilitates the dispersion of the brine. The

use of an inert gas being air- and water-soluble such as carbon dioxide is believed to assist the despersion of muscle fibres as well as resulting in an improved pH-value. Using an inert gas only causes a mechanical effect as the gas is insoluble in the water phase of the meat and does not interfere with the pH-value of the meat, possibly disacidifying nitrogen. Further characteristics of the method are disclosed in the claims.

An equipment for applying said method where the meat is tumbled in a sealed tank is characteristic in having ultrasound transducers placed at or inside the portion of the tank where the meat is contained, these ultrasound transducers are arranged such that the meat is subjected to ultrasound as well as comprising a vacuum source and a compressed-air source arranged such that the tank can be pressurized by an alternating pressure between vacuum and overpressure, as during the pressure phases a water-soluble gas being free from oxygen and being meat acidulating such as carbon dioxide and an inert gas such as nitrogen can be let in, respectively. It is insignificant whether the tank is a stationary tank or an unattached movable tank, and it is without importance, too, whether the tank is vertical or horizontal. Nor is it vital whether the tank be rotated to perform a tumbling of the meat or whether inside the tank stirring arms or stirrers are provided for processing the meat. But of course it influences the actual embodiment of the equipment, such as positions of the ultrasound transducers and connection for vacuum/over pressure in the tank. With regard to the ultrasound transducers it is preferred to place these inside a concentrically situated sealed tube or cylinder inside the tank and passing through the end bottom and fixed to the frame construction. For removal of excess heat from a.o. the ultrasound transducers the tank can appropriately be provided with a cooling jacket. The tempera-

ture should be kept at a minimum, preperably at approximately 2°C. Further details pertaining to the equipment are disclosed in the following specification in connection with the attached drawing as well as in the claims.

The drawing illustrates the following:-

Fig. 1 is a lateral view of an equipment according to the invention illustrating the tank in its tumbling position.

Fig. 2 is an end view and partly a sectional view of the equipment as seen from the front.

Fig. 3 is a lateral view having the tank tilted to its filling position.

Fig. 4 is also a lateral view having the tank tilting in its discharging position.

Fig. 5 is a section of the tube with the ultrasound transducers on line B-B in Fig. 2.

Fig. 6 illustrates an enlarged cross section of a transducer fastened inside the tube.

Fig. 7 illustrates another design of the equipment according to the invention based on a stationary tank provided with ultrasound transducers at the bottom, and

Fig. 8 is a direct horizontal view of the equipment according to Fig. 7 offering a view of the interior of the tank through a plexiglass cover.

The equipment comprises a frame 2, at which a sealed pressure/vacuum tank 4 is arranged having access through a specially constructed cover 6. The drum is supported by a tilting frame 8 having two support rollers 10 at the front and on which the drum rests. At the rear the tank is resting at a bearing 12 and can be pulled by a motor 14 via a gear such that the tank can be brought to rotate about its axis of rotation. At the corners the frame is held by upwardly open bearing bushes 16. As illustrated by Figs. 3 and 4 the hydraulic

cylinders 18 can bring the tank to a filling position (Fig. 3) and a discharging position (Fig. 4). For the filling position the front of the tilting frame is lifted such that the tank is tilting rearwardly for loading meat. During discharging the rear of the tilting frame is lifted such that the supply opening faces downwardly for unloading the meat into wheeled containers 20. Inside the tank 4 a sealed tube 22 is placed coaxially, the tube having a square cross-section and a number of ultrasound transducers 24 being placed inside it. The tube protrudes through the end cover 26 of the tank and is fastened, i.e. they are suspended inside the tank and do not rotate. Wires and other electrical equipment are run out through the pipe and gathered in a cabinet 28. The square tube is placed edgeways, cf. Fig. 5 such that two adjacent sides 30, 32 face downwardly towards the lower side 34 of the tank. Over the entire length of the tube ultrasound transducers 24 have been installed on these two sides. For reasons of space they have been mutually aligned such that they alternately point at either direction. Fig. 6 shows an enlarged cross-section of the position of an ultrasound transducer. The actual ultrasound transducer has been placed in a bushing, the transducer being vulcanized to the bushing by white nitrite 38. The bushing is fastened to the lateral wall such that the ultrasound transducers are placed directly facing the interior of the tank only being separated by the vulcanizing layer, which proves to absorb only a negligible amount of the energy generated by the transducer. The other end of the bushing is sealed by an end cover 40 fastened by a nut 42. The end cover comprises an inlet 44 for the transducer. As the degree of filling up the tank normally is approx. 80% and always above 50% the meat will be in direct contact with the transducers and the ultrasound will spread through the entire bulk of meat and the tumbling will

ensure that all meat gradually passes through the transducer tube. It is pointed out that the tube can have other geometric cross-sections than exactly square, e.g. triangular, rectangular or multiangular, cylindrical. Obviously the free end of the tube can also be supported in a slide bearing, e.g. fastened in a radially running arm in the tank. The actual ultrasound generator, the effect of which is matched to the meat to be cured, is not illustrated nor is the other control equipment. As an example a frequency in the region of 22-29 KHz can be mentioned, preferably 25 KHz and an adjustable effect ranging from 0-400 watt/transducer.

The evacuation of the tank and feed of compressed air in the form of carbon dioxide and nitrogen is performed through an especially designed inlet in the cover 26 of the tank. This takes place through special couplings situated at the rotation axis of the tank allowing the tank to rotate during evacuation and pressure feeding of the inert gases. The tank is kept at a rotational speed of 2-20 revolutions per minute during this operation. Pressure pump, vacuum pump and the gas tanks are not illustrated.

The location of the ultrasound transducers offers rather the uptimum transmission of the ultrasonic waves to the content of the tank. In order to maintain a temperature of approx. 2°C the tank can be provided with a cooling jacket not shown in the drawing. The requirement to maintain a low temperature is partly due to veterinary reasons, but also due to the curing of the meat being more efficient at low temperatures.

Figs. 7 and 8 illustrate an upright, stationary model, where the tank 4 comprises three supports 46. Underneath the bottom an arrangement comprising seven ultrasound transducers 24 is placed. The tank is provided with a removable, heavy plexiglass cover 48 facilitating a visual survey of the process. The ultrasound

transducers, incidentally, are fastened as before. The cover has a connection 50 for pressure/vacuum.

It will be realized that the equipment described has a particularly simple design and offers uncomplicated reliability of operation.

C L A I M S:

1. A method for curing meat such as pork, beef or veal that is subject to tumbling in a sealed tank upon brine being added, preferably by injection, characterized in that the meat at the subsequent tumbling is subject to ultrasound together with an alternating pressure between vacuum and overpressure as during the pressure phases inactive gases such as carbon dioxide and nitrogen are added.

2. A method according to claim 1, characterized in that

a) the mechanical curing of meat with brine in the tank takes place at a degree of filling of 20-85%, preferably 50-80% in the tank, that the alternating pressure is from 0.001 bar absolute to a maximum of 8 bar, preferably max. 6 bar,

b) that during curing gas is extracted until the pressure in the tank is at 0.001-0.005 bar absolute,

c) subsequently still during curing a water-soluble gas being free from oxygen and being meat acidulating be let in until the pressure in the tank has reached a minimum of 1 bar and a maximum of 6 bar,

d) that the pressure be kept for a minimum of 5 and a maximum of 40 minutes,

e) that the pressure subsequently be reduced successively/stepped to approx. 0.001 bar absolute and maintained here for 5-60 minutes, preferably for 50 minutes,

f) that stages c), d) and e) possibly be repeated once or more times until a total curing time of 1-6 hours has passed, preferably 3 hours,

g) upon which the vacuum be broken by the letting in of an inert gas to the tank until atmospheric pressure be achieved in the tank, such that the meat can be

removed.

3. A method according to claim 2, characterized in that the water-soluble gas is carbon dioxide let in at such pressure and in such quantity that the pH-value becomes approx. 5.2.

4. A method according to claims 2 and 3, characterized in that in those cases where the brine injection is performed preceding the mechanical curing of the lumps of meat and the brine increase be relatively moderate, extra ingredients are added to the injection brine or the tank, said ingredients being dry sugar products, aqueous solutions of ascorbic acid or Na-ascorbate, hydrocelloids and/or similar ingredients.

5. A method according to claims 2,3 or 4, characterized in that the inert gas for equalizing the pressure in the tank upon the completion of the final vacuum stage is a gas which is insoluble in the aqueous phase of the meat and cannot alter the acidity of the meat, such as nitrogen.

6. An equipment for curing meat, such as pork, beef or veal comprising a sealed tank (4), in which the meat can be subjected to a tumbling, as the meat precedingly has received brine, preferably by injection, characterized in that at or inside the tank (4) containing the meat ultrasound transducers (24) are placed, arranged such that the meat is subjected to ultrasound as well as comprising a vacuum source and a compressed-air source such that the tank can be pressurized by an alternating pressure between vacuum and overpressure, as during the pressure phases inactive gases such as carbon dioxide and nitrogen can be let in.

7. An equipment according to claim 6, characterized in that it comprises a cooling source, e.g. a cooling jacket to keep the temperature of the tank constant at a low temperature, preferably at a maximum of 2°C.

8. An equipment according to claim 6 comprising a horizontal rotationsymmetrical tank (4) that can be brought to rotate about its longitudinal axis, characterized in that ultrasound transducers (24) are placed inside the tank, mounted in a concentrically situated tube or cylinder (22).

9. An equipment according to claim 8, characterized in that the tube (22) with the ultrasound transducers has a square cross-section and is placed edgeways such that two adjacent sides (30, 32) face downwardly towards the lower side (34) of the tank, and that the transducers are placed at these two sides.

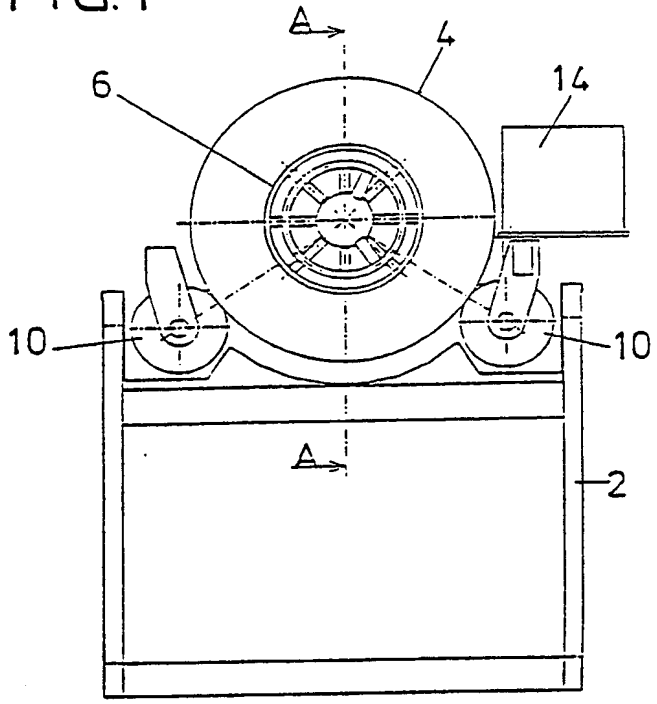
10. An equipment according to claim 6, characterized in that the tank is supported by a tilting frame that can have a filling position for the tank where the front of the frame is tilted upwardly about a horizontal, transverse axis at the rear of the frame, and a discharging position for the tank where the rear of the frame is tilted upwardly about a horizontal axis at the rear of the frame and a rotation position where the tank is in its horizontal position.

11. An equipment according to claim 8, characterized in that the tanks have connection branches for letting gas in and out during the rotation of the tank and arranged such that the meat be cured mechanically under alternating pressure between vacuum and overpressure from 0.001 bar to a maximum of 8 bar such that during curing gas can be extracted by a vacuum source

until the pressure in the tank decreases to 0.001-0.005 bar absolute and that during curing, i.e. during rotation of the tank a water-soluble meat acidulating gas can still be let into the tank through a compressed-air source, until the pressure in the tank has increased to min. 1 and max. 6 bar, and that the pressure by the vacuum source subsequently can be decreased successively/stepped to approx. 0.005 bar absolute and arranged such that the vacuum can be broken by letting in an inert gas to the tank until atmospheric pressure has been reached in the tank.

12. An equipment according to claim 11, characterized in that the connecting branches for letting in and out gas are placed in the end cover (6) of the tank.

FIG.1



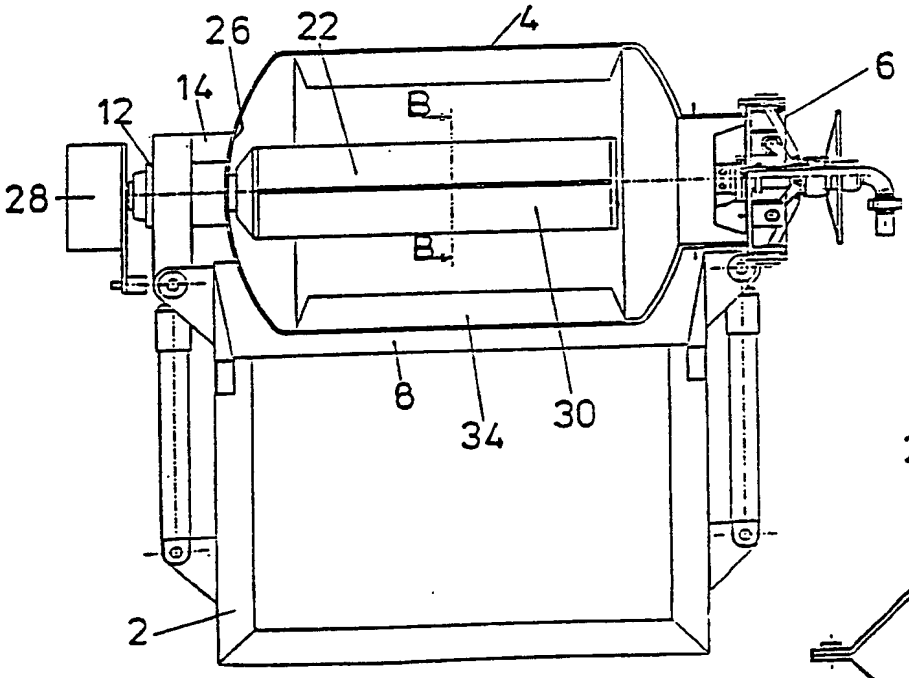


FIG. 2

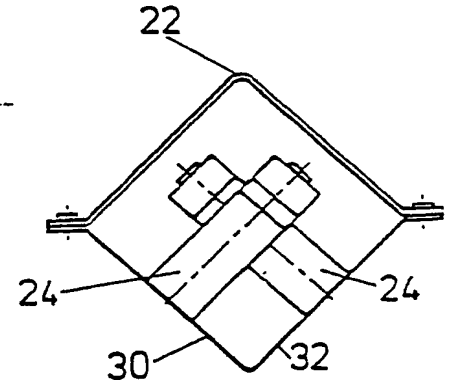
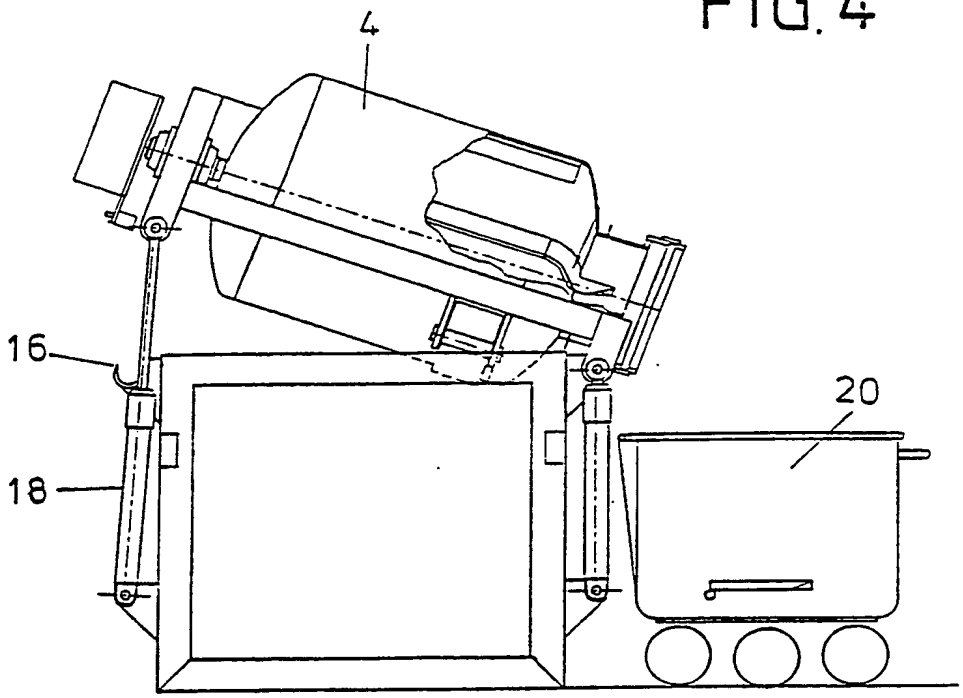


FIG. 5

FIG. 4



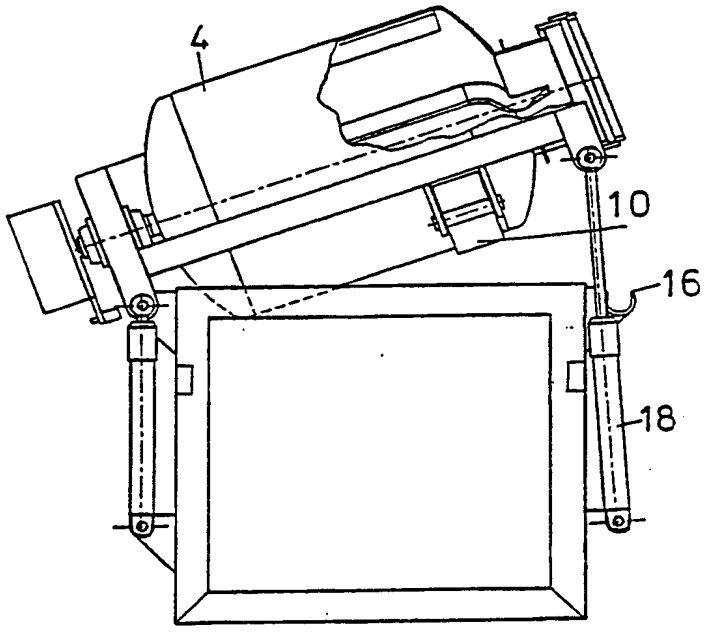


FIG. 3

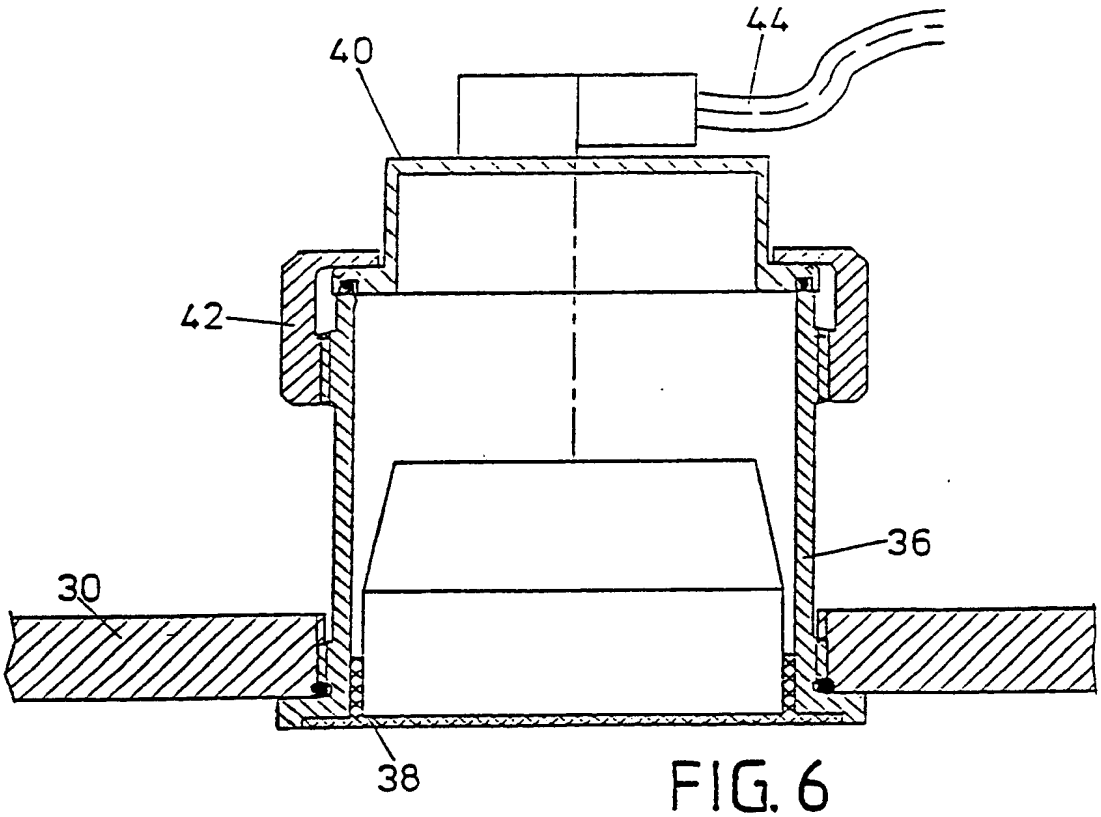


FIG. 6

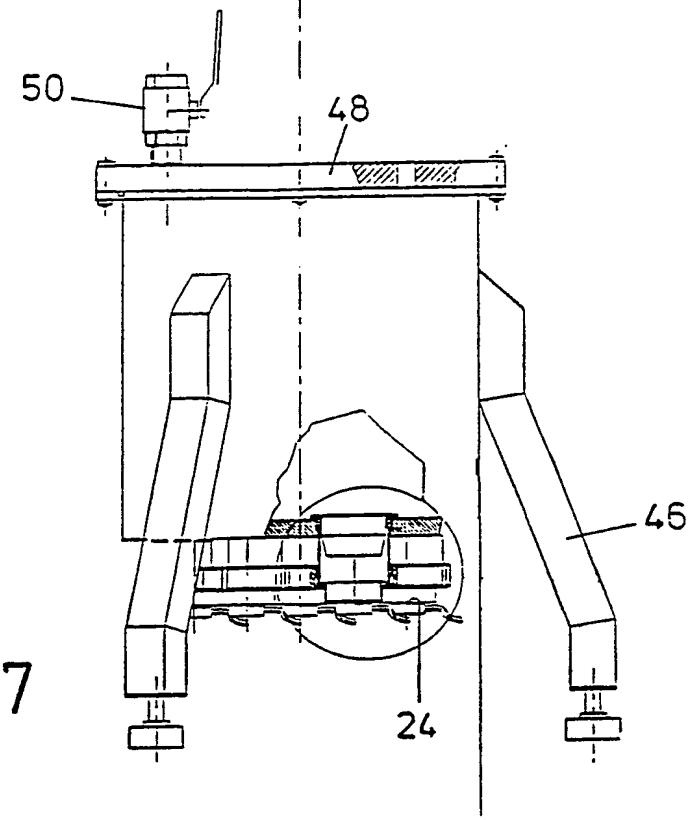


FIG. 7

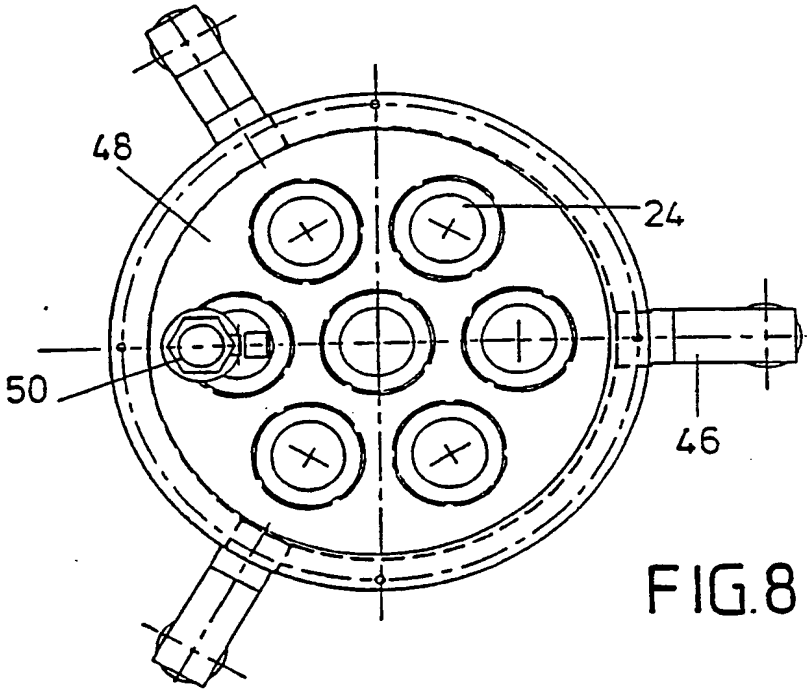


FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK 92/00113

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: A 22 C 9/00, A 23 B 4/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	A 22 C; A 23 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	SE, B, 452093 (JAN ANDERSSON) 16 November 1987, see esp. page 3, line 27 - page 4, line 10 --	1-12
Y	US, A, 3711896 (JERALD GUBERMAN ET AL) 23 January 1973, see esp. column 1, line 6 - line 12; column 3, line 43 - column 4, line 16 --	1-12
A	WO, A1, 8908982 (INJECT STAR PÖKELMASCHINEN GESELLSCHAFT M.B.H.) 5 October 1989, see esp. claim 5 --	1-12
A	GB, A, 1593821 (ASSICO IMPORT AND EXPORT GMBH & CO. K.G., ET AL) 22 July 1981, see esp. claim 1 --	1-12

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
9th July 1992	1992 -07- 14
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Kerstin Boije Jansson

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/DK 92/00113

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 29/05/92
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SE-B- 452093	87-11-16	SE-A- 8303982	85-01-15
US-A- 3711896	73-01-23	NONE	
WO-A1- 8908982	89-10-05	AT-B- 392197	91-02-11
		EP-A- 0406231	91-01-09
		JP-T- 3500121	91-01-17
GB-A- 1593821	81-07-22	BE-A- 862636	78-05-02
		CH-A- 615808	80-02-29
		DE-A-C- 2700125	78-07-06
		FR-A-B- 2375830	78-07-28
		JP-C- 1284345	85-10-09
		JP-A- 53121233	78-10-23
		JP-A- 53121981	78-10-24
		NL-A- 7800053	78-07-06